The Status of Emerald Ash Borer in North America

Steven Katovich
USDA Forest Service
Forest Health Protection

Outline

- Background information and life cycle
- Signs and symptoms of infestation
- Current EAB status in North America and how we reached our present situation………

EAB – what was known in August 2002

Yu Yu, Chengming 1992. Agrilus marcopoli Obenberger (Coleoptera: Buprestidae), pp 400-401. In G. Xiao [ed.], Forest Insects of China (2nd edition). China Forestry Publishing House, Beijing, China. Forestry Publishing House, Beijing, China.

Institute of Zoology, Chinese Academy of Science. 1986. Agrilus marcopoli Obenberger. Agriculture Insects of China (part I), p. 445. China Agriculture Press, Beijing, China.

We were unsure of the host range, flight capability, how long adult beetles lived, what insecticides would kill EAB, was there a sex pheromone present, how do we trap EAB adults??????

Research and Technology Development meetings 2003-2009


Forest Health Technology Enterprise Team
TECHNOLOGY TRANSFER
Emerald Ash Borer

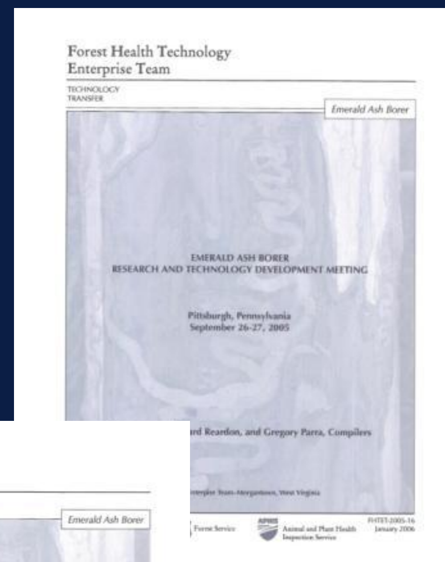
EMERALD ASH BORER
RESEARCH AND TECHNOLOGY DEVELOPMENT MEETING

Romulus, Michigan
October 5-6, 2004

Victor Mastro and Richard Reardon, Compilers

Forest Health Technology Enterprise Team–Morgantown, West Virginia

USDA U.S. Department of Agriculture | Forest Service | APHIS Animal and Plant Health Inspection Service
FHTET-2004-15
January 2005


Forest Health Technology Enterprise Team
TECHNOLOGY TRANSFER
Emerald Ash Borer

EMERALD ASH BORER
RESEARCH AND TECHNOLOGY DEVELOPMENT MEETING

Pittsburgh, Pennsylvania
September 26-27, 2005

...rd Reardon, and Gregory Parra, Compilers

...erprise Team–Morgantown, West Virginia

Forest Service | APHIS Animal and Plant Health Inspection Service
FHTET-2005-16
January 2006


Forest Health Technology Enterprise Team
TECHNOLOGY TRANSFER

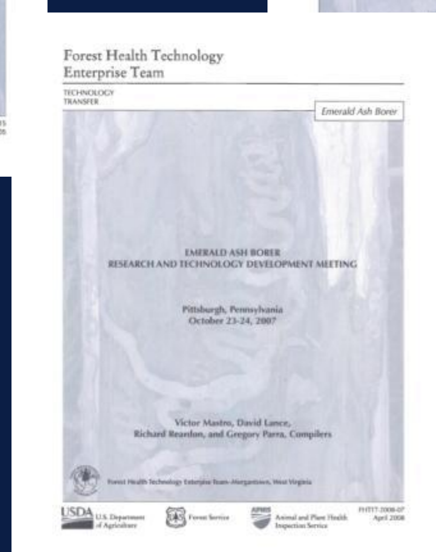
EMERALD ASH BORER
RESEARCH AND TECHNOLOGY DEVELOPMENT MEETING

Port Huron, Michigan
September 30-October 1, 2003

Victor Mastro and Richard Reardon, Compilers

Forest Health Technology Enterprise Team–Morgantown, West Virginia

USDA U.S. Department of Agriculture | Forest Service | APHIS Animal and Plant Health Inspection Service
FHTET-2004-02
January 2004


Forest Health Technology Enterprise Team
TECHNOLOGY TRANSFER
Emerald Ash Borer

EMERALD ASH BORER
RESEARCH AND TECHNOLOGY DEVELOPMENT MEETING

Pittsburgh, Pennsylvania
October 23-24, 2007

Victor Mastro, David Lance,
Richard Reardon, and Gregory Parra, Compilers

Forest Health Technology Enterprise Team–Morgantown, West Virginia

USDA U.S. Department of Agriculture | Forest Service | APHIS Animal and Plant Health Inspection Service
FHTET-2008-07
April 2008


Forest Health Technology Enterprise Team
TECHNOLOGY TRANSFER
Emerald Ash Borer
Asian Longhorned Beetle

EMERALD ASH BORER AND ASIAN LONGHORNED BEETLE
RESEARCH AND TECHNOLOGY DEVELOPMENT MEETING

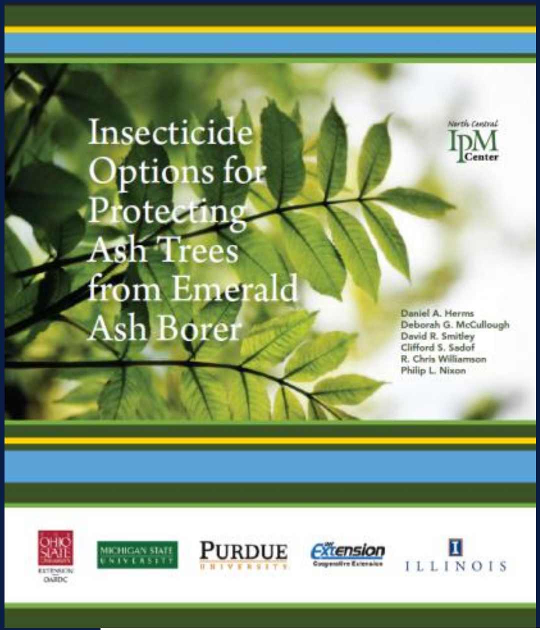
Cincinnati, Ohio
October 29-November 2, 2006

Victor Mastro, David Lance,
Richard Reardon, and Gregory Parra, Compilers

Forest Health Technology Enterprise Team–Morgantown, West Virginia

USDA U.S. Department of Agriculture | Forest Service | APHIS Animal and Plant Health Inspection Service
FHTET-2007-04
March 2007

Information available in 2010 --



HOW FAST WILL TREES DIE? A TRANSITION MATRIX MODEL OF ASH DECLINE IN FOREST STANDS INFESTED BY EMERALD ASH BORER

Kathleen S. Knight[1], Robert P. Long[1], Joanne Rebbeck[1], Annemarie Smith[2], Kamal Gandhi[3], and Daniel A. Herms[3]

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ABSTRACT

We recorded *Fraxinus* spp. tree health and other forest stand characteristics for 68 plots in 21 EAB-infested forest stands in Michigan and Ohio in 2005 and 2007. *Fraxinus* spp. were a dominant component of these stands, with more than 900 ash trees (including *Fraxinus americana*, *Fraxinus pennsylvanica*, *Fraxinus profunda*, and *Fraxinus nigra*) monitored at different sites. Ash condition was rated on a scale of 1 to 5, where '1' represented a healthy tree, '5' represented a dead tree, and '2' to '4' indicated stages of dieback. Individual trees were tracked through time by matching tree diameter and position in the plot.

A general linear multivariate mixed model was used to test the effect of ash condition in 2005 (ordinal), tree diameter, ash species, stand condition in 2005 (average ash condition), habitat, ash density, stand average ash diameter, and ash composition on ash condition in 2007 (ordinal), with individual ash trees as the unit of replication. Ash condition in 2005 was correlated with ash condition in 2007, which showed that trees that were in poor condition in 2005 were likely to be in poor condition or dead in 2007. Smaller-diameter trees underwent more rapid changes in ash condition within the two-year period than did larger-diameter trees. Stand condition in 2005, the average of the ash condition for all ash trees in the stand, was a strong predictor of ash condition in 2007. As the average condition of the stand declined, individual ash trees declined more rapidly.

J Chem Ecol (2007) 33:1430–1448
DOI 10.1007/s10886-007-9312-3

Comparative Phloem Chemistry of Manchurian (*Fraxinus mandshurica*) and Two North American Ash Species (*Fraxinus americana and Fraxinus pennsylvanica*)

Alieta Eyles · William Jones · Ken Riedl · Don Cipollini · Steven Schwartz · Kenneth Chan · Daniel A. Herms · Pierluigi Bonello

Received: 12 March 2007 / Revised: 26 April 2007 / Accepted: 7 May 2007 /
Published online: 24 May 2007

Abstract Recent studies have investigated interspecific variation in resistance of ash (*Fraxinus* spp.) to the exotic wood-boring beetle, emerald ash borer (EAB, *Agrilus planipennis*). Manchurian ash (*Fraxinus mandshurica*) is an Asian species that has coevolved with EAB. It experiences little EAB-induced mortality compared to North American ashes. Host phloem chemistry, both constitutive and induced, might partly explain this interspecific variation in resistance. We analyzed the constitutive phloem chemistry of three ash species: Manchurian ash and North American white (*Fraxinus americana*) and green (*Fraxinus pennsylvanica*) ash. Analysis of the crude phloem extracts revealed the presence of an array of phenolic compounds including hydroxycoumarins, a

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Division Of Pharmaceutics, College Of Pharmacy, The Ohio State University, 308 Comprehensive Cancer Center, 410 W 12th Ave, Columbus, OH 43210, USA

SAMPLING

Effectiveness of Differing Trap Types for the Detection of Emerald Ash Borer (Coleoptera: Buprestidae)

JORDAN M. MARSHALL,[1,2] ANDREW J. STORER,[1] IVICH FRASER,[3] JESSICA A. BEACHY,[1] AND VICTOR C. MASTRO[4]

Environ. Entomol. 38(4): 1226–1234 (2009)

ABSTRACT The early detection of populations of a forest pest is important to begin initial control efforts, minimizing the risk of further spread and impact. Emerald ash borer (*Agrilus planipennis* Fairmaire) is an introduced pestiferous insect of ash (*Fraxinus* spp. L.) in North America. The effectiveness of trapping techniques, including girdled trap trees with sticky bands and purple prism traps, was tested in areas with low- and high-density populations of emerald ash borer. At both densities, large girdled trap trees (>30 cm diameter at breast height [dbh], 1.37 m in height) captured a higher rate of adult beetles per day than smaller trees. However, the odds of detecting emerald ash borer increased as the dbh of the tree increased by 1 cm for trap trees 15–25 cm dbh. Ash species used for the traps differed in the number of larvae per cubic centimeter of phloem. Emerald ash borer larvae were more likely to be detected below, compared with above, the crown base of the trap tree. While larval densities within a trap tree were related to the species of ash, adult capture rates were not. These results provide support for focusing state and regional detection programs on the detection of emerald ash borer adults. If bark peeling for larvae is incorporated into these programs, peeling efforts focused below the crown base may increase likelihood of identifying new infestations while reducing labor costs. Associating traps with larger trees (~25 cm dbh) may increase the odds of detecting low-density populations of emerald ash borer, possibly reducing the time between infestation establishment and implementing management strategies.

ISA
Arboriculture & Urban Forestry 2007. 33(5):338–349.
ARBORICULTURE & URBAN FORESTRY

Emerald Ash Borer (*Agrilus planipennis*) Density and Canopy Dieback in Three North American Ash Species

Andrea C. Anulewicz, Deborah G. McCullough, and David L. Cappaert

Abstract. Emerald ash borer (*Agrilus planipennis* Fairmaire) (Coleoptera: Buprestidae), a phloem-feeding insect native to Asia, was identified in 2002 as the cause of widespread ash (*Fraxinus*) mortality in southeast Michigan, U.S. and Windsor, Ontario, Canada. Little information about *A. planipennis* is available from its native range and it was not known whether this invasive pest would exhibit a preference for a particular North American ash species. We monitored *A. planipennis* density and canopy condition on green ash (*F. pennsylvanica*) and white ash (*F. americana*) street trees in four neighborhoods and on white and blue ash (*F. quadrangulata*) trees in two woodlots in southeast Michigan. Green ash street trees had significantly more canopy dieback and higher *A. planipennis* densities than white ash trees growing in the same neighborhood. Density increased by two- to fourfold in both species over a 3-year period. Canopy dieback increased linearly from 2002 to 2005 as *A. planipennis* density increased ($R^2 = 0.70$). In each of the woodlots, *A. planipennis* densities were significantly higher on white ash trees than blue ash trees. Woodpecker predation occurred in all sites and accounted for 35% of the *A. planipennis* that developed on trees we surveyed. Results indicate that surveys for *A. planipennis* detection in areas with multiple ash species should focus on the relatively preferred species.

Key Words. Blue ash; emerald ash borer; *Fraxinus*; green ash; host preference; insect survey; invasive pest; white ash; woodpecker.

Emerald Ash Borer
Agrilus planipennis

- Adults are about 3/8 inch long, members of the beetle family, Buprestidae
- *Agrilus* is a common genus in North America, it includes the bronze birch borer, *Agrilus anxius*; and the twolined chestnut borer, *Agrilus bilineatus*.

Emerald Ash Borer
Agrilus planipennis

- Native to NE China, Korea, Russian Far East, Taiwan and Japan
- It is not considered a major forest or tree pest in Asia
- Little information available on emerald ash borer in its native range

Emerald Ash Borer
Agrilus planipennis

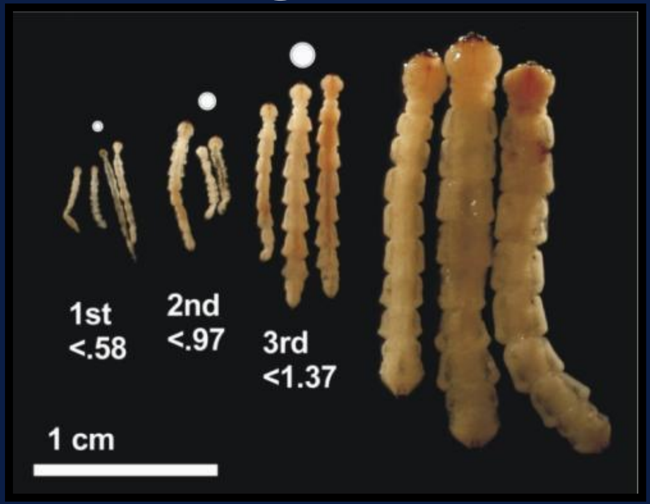
- North American host range includes only *Fraxinus* at this time
- Initial Asian reports included a wider host range (*Ulmus* and *Juglans*), but this has been largely discounted in U.S. and Canadian studies

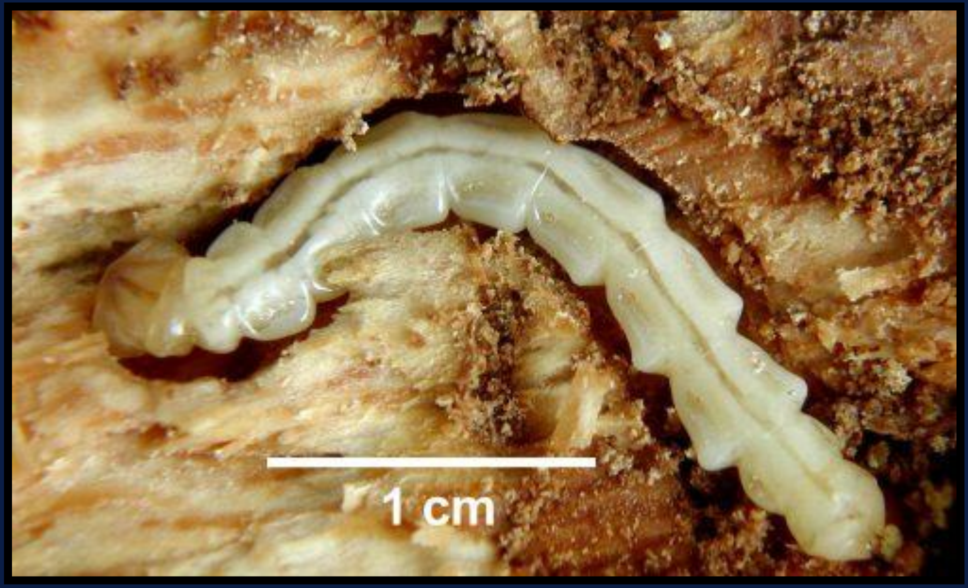
Emerald ash borer life cycle

Adults present June to mid-August. Each adult lives ca. 3 weeks. Beetles feed on ash foliage.

Adults mate; female lays single eggs on or just under bark; 30-60 eggs per female.

Larvae bore under bark & feed aggressively in the cambium and phloem; 4 larval stages.



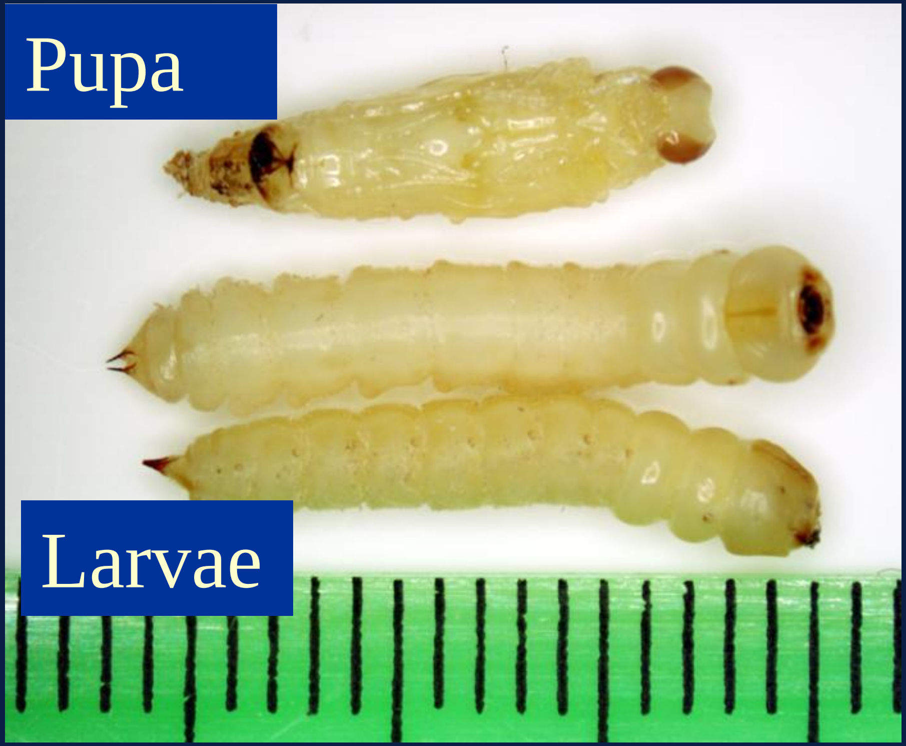


Feeding is generally completed by late September or October. A one year life cycle is most common, two year life cycles have been observed at new introduction sites

How does EAB kill a tree?

Larvae feed in the cambial and phloem tissue – damage to phloem tissue limits a trees ability to transport “food” produced in the crown to the roots, the roots begin to die….

Pre-pupal larvae overwinter in bark or wood. Cold temperatures have little effect on survival

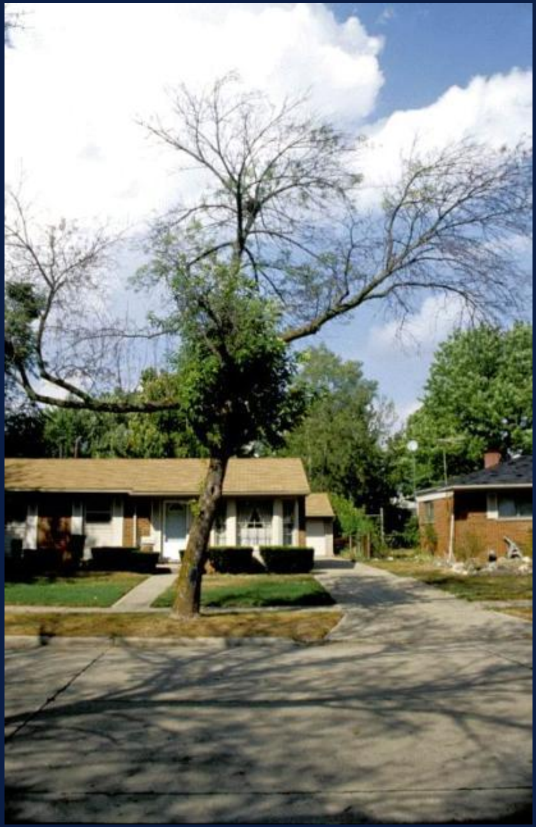


Pupation begins in April & May

Adults emerge from D-shaped exit holes in late May, June & July.

Initial symptoms include branch dieback and overall decline. Trees generally die 2-4 years after initial attacks.

EAB



EAB

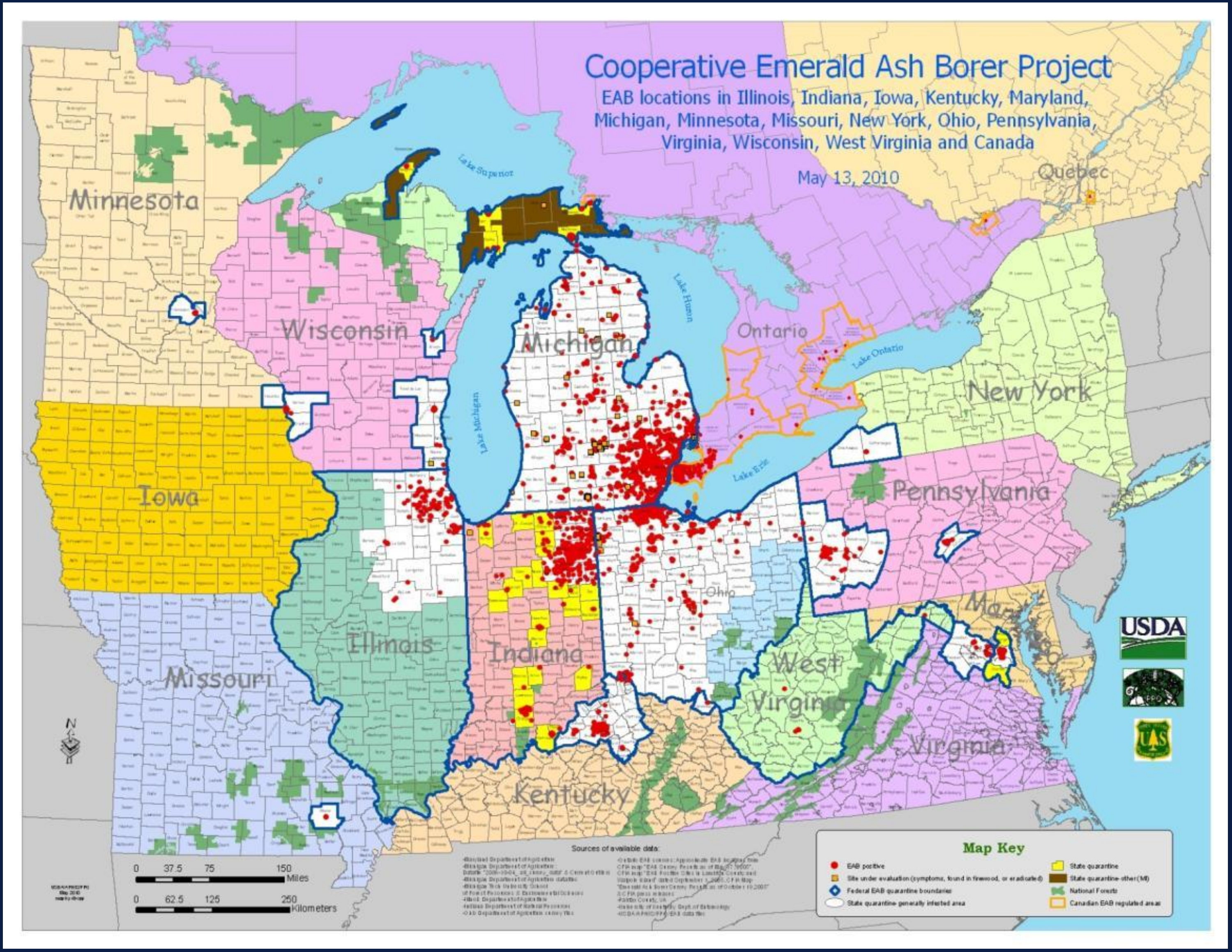
Decline

Symptoms – Very distinctive larval galleries, bark may split-open over a gallery.

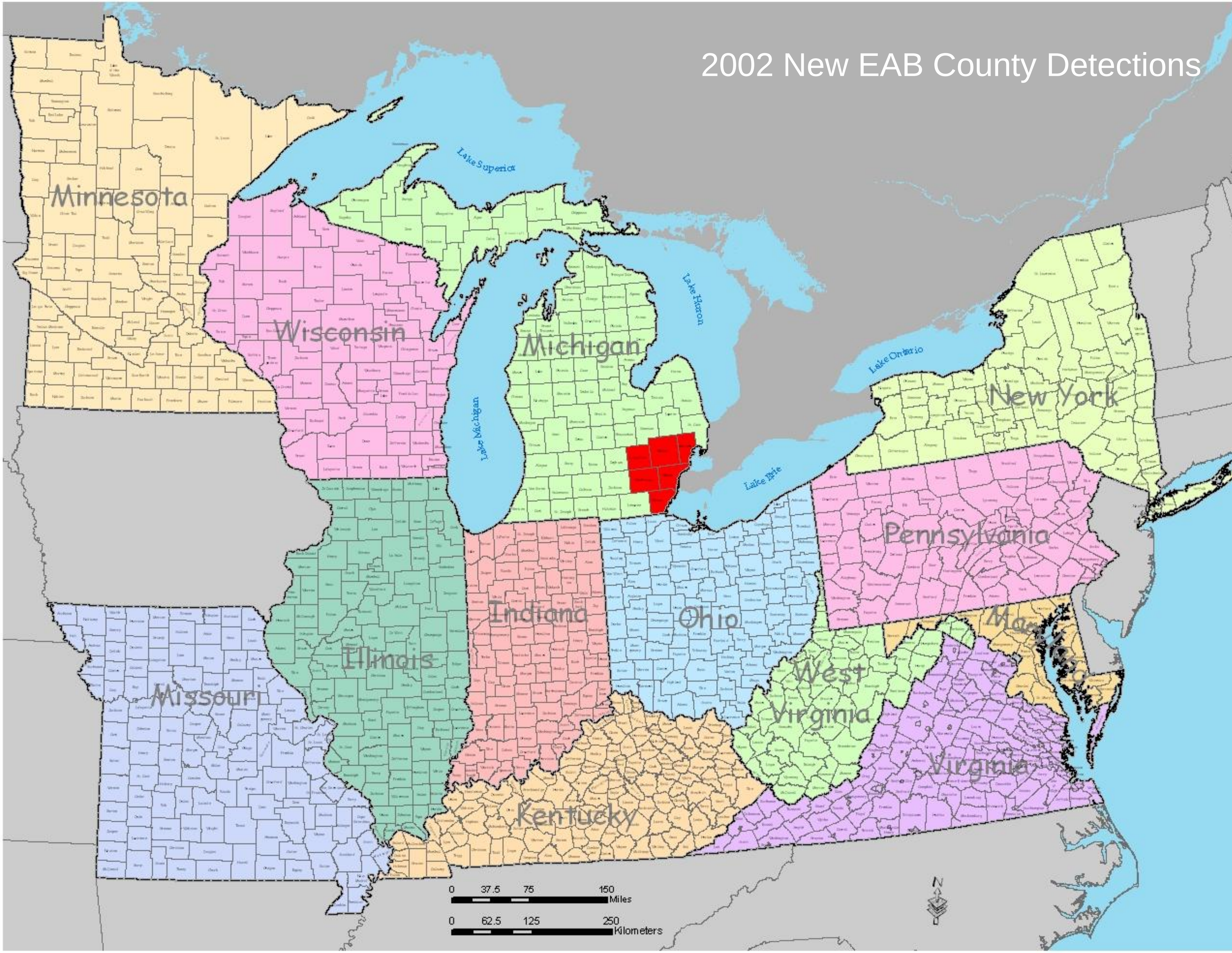
D-shaped exit Holes.

Symptoms - Woodpeckers remove patches of the bark in late winter and early spring. Also note the presence of suckers on infested trees.

Current Status - Spring 2010



2002 New EAB County Detections



Sample Area in Southeastern MI

- Sampling in southeastern MI encompassed the original 2002 quarantine
- Dendrochronological reconstruction done by Nate Siegert, MSU

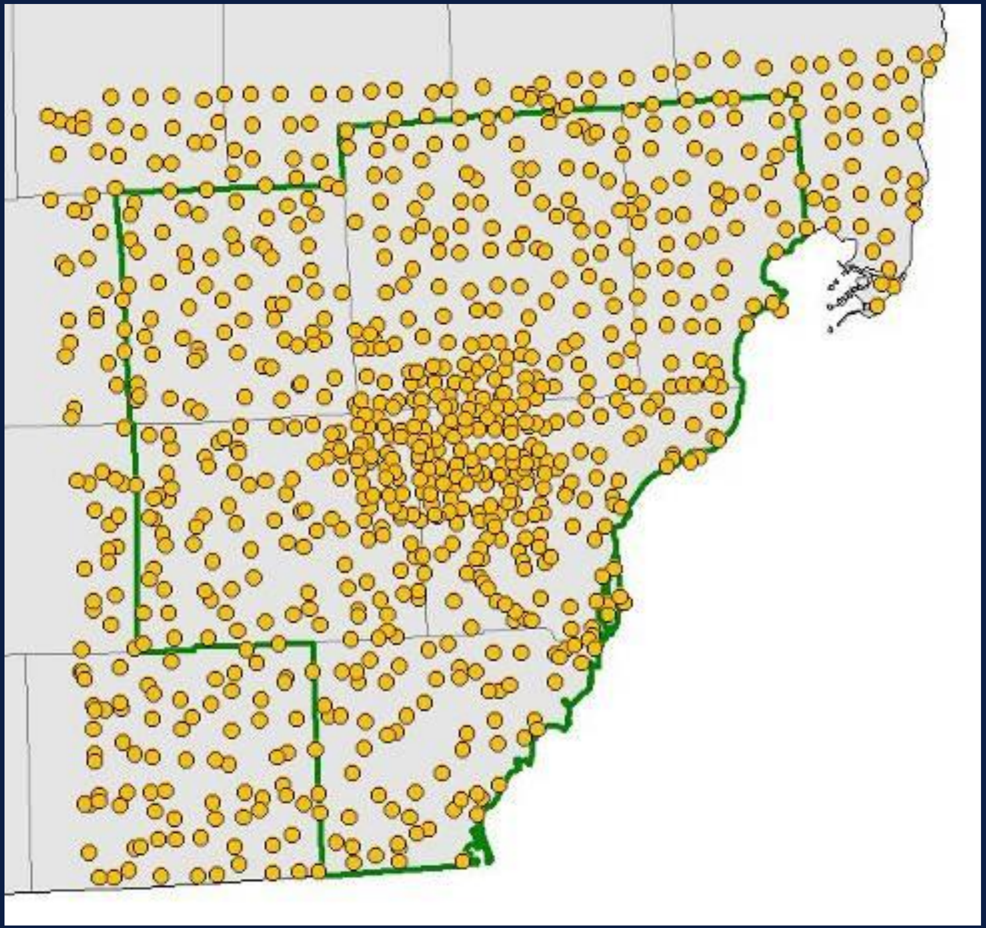
Collecting Increment Cores

EAB-killed trees sampled over declining non-stressed

2-4 increment cores collected per tree

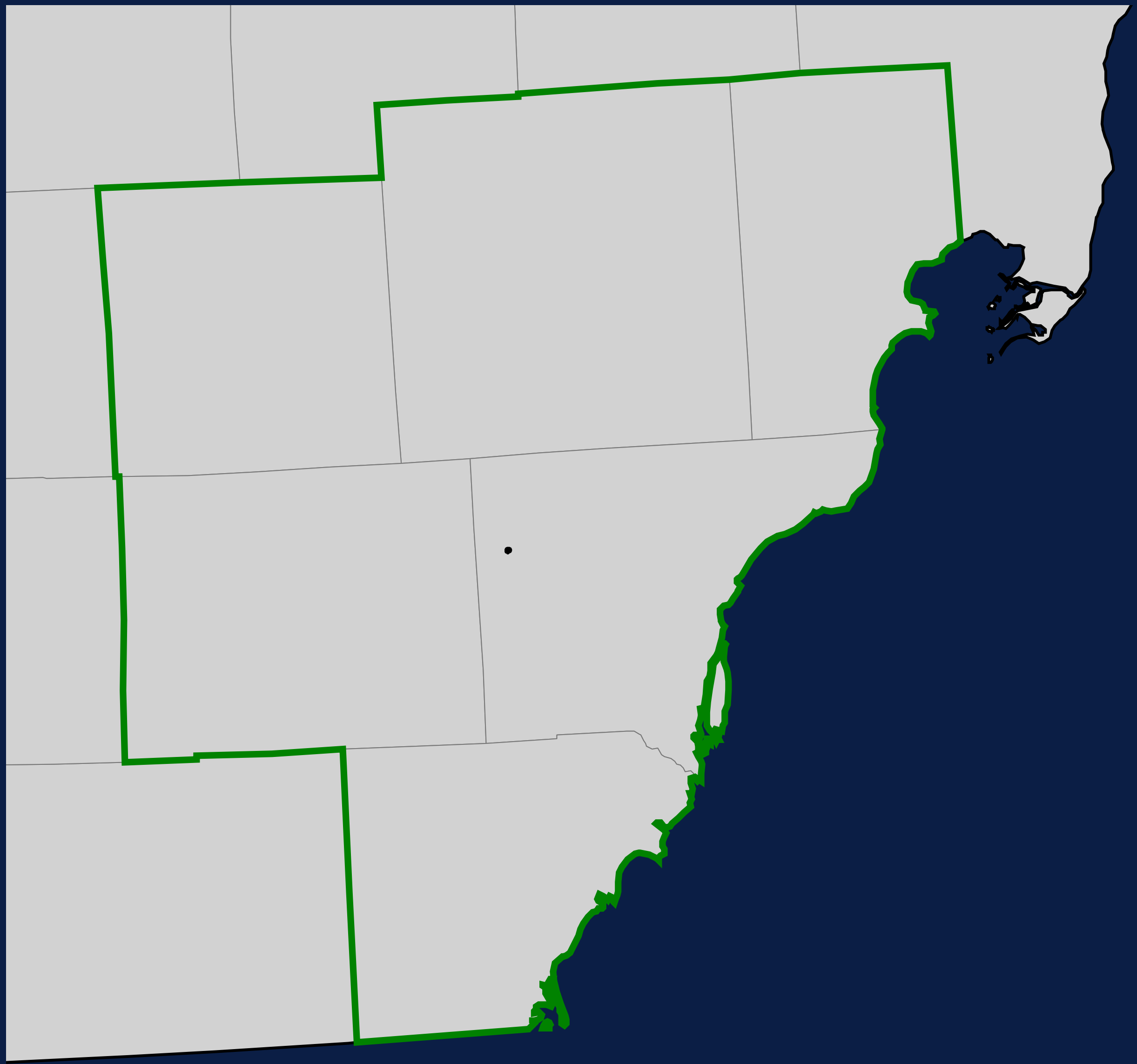
Sample Area in Southeastern MI

- Area sampled was >15,000 km^2
- Infested ash trees preferentially sampled ≤4.8 4.8 km sampling grid (1085 trees)
- 645 sample points were used in the spatial analysis



Preliminary Results

1997



Stem Analyses - Outliers

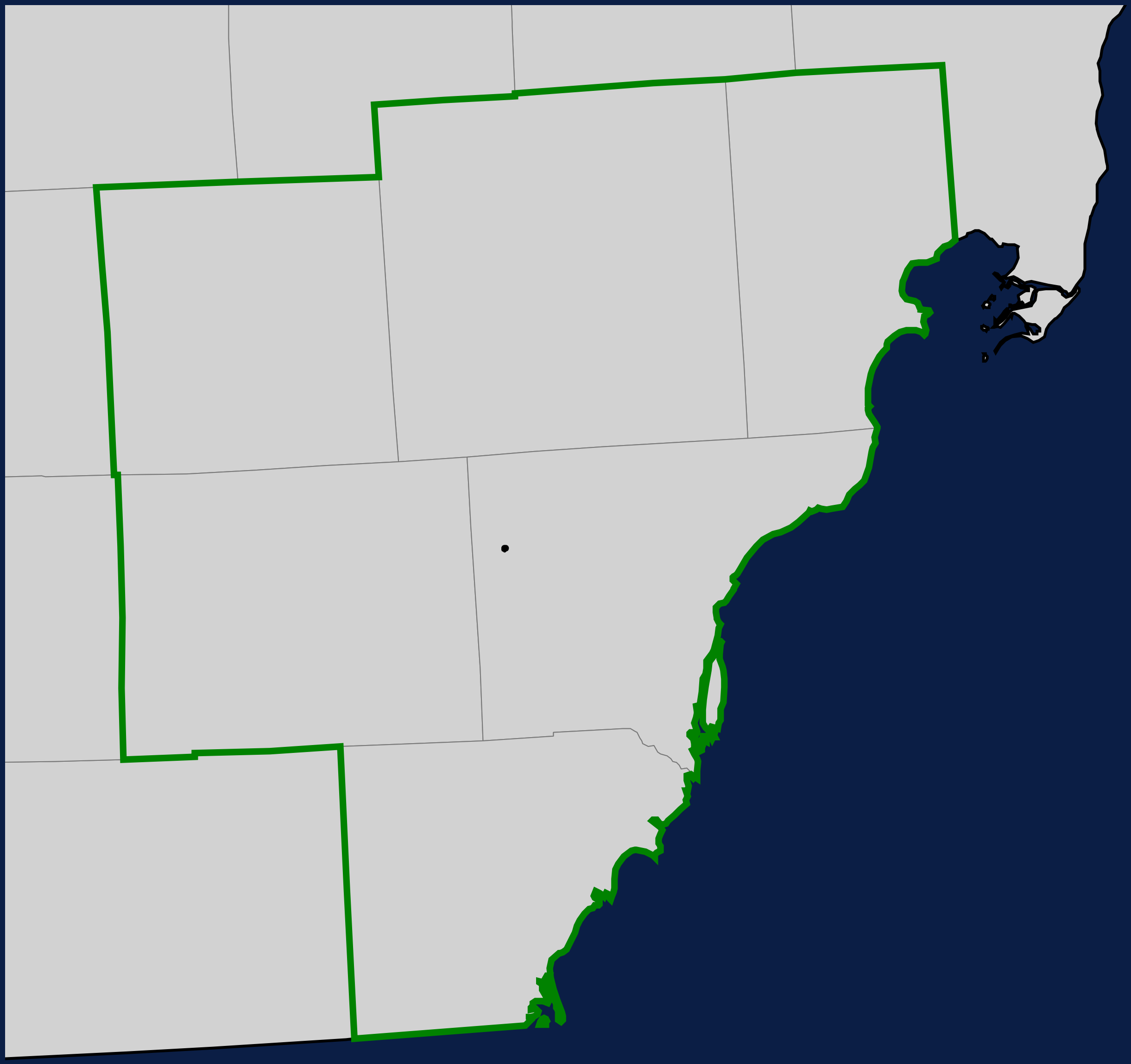
Sites tend to be infested for 3-5 years before dead trees occur

If the first dead trees occurred in 1997, the initial introduction was likely in 3-5 years earlier.


ICE
No. 15
MADE IN CHINA
ICE
No. 16
MADE IN CHINA
ICE
No. 13
MADE IN CHINA
ICE
No. 11
MADE IN CHINA

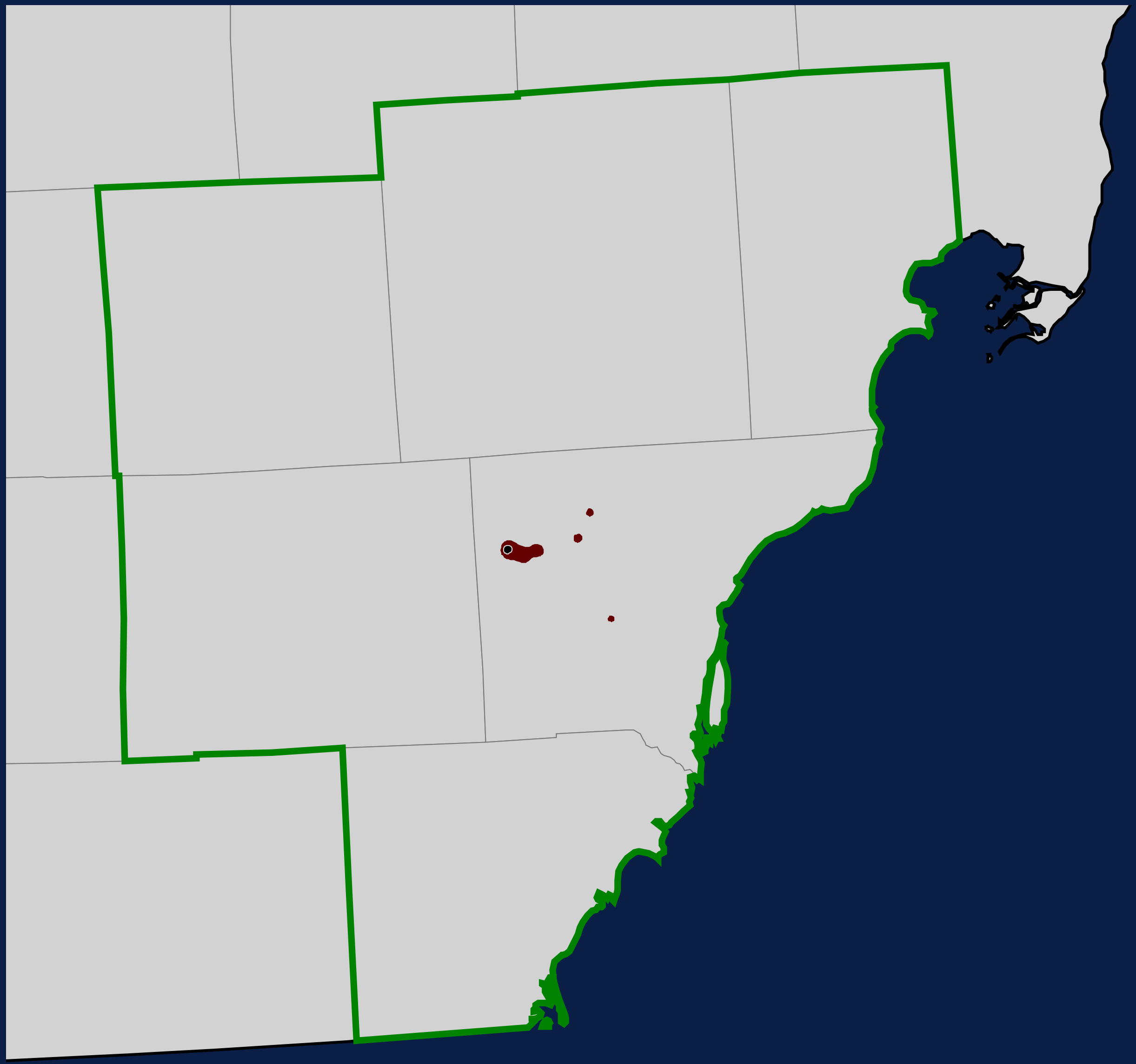
Preliminary Results

1997



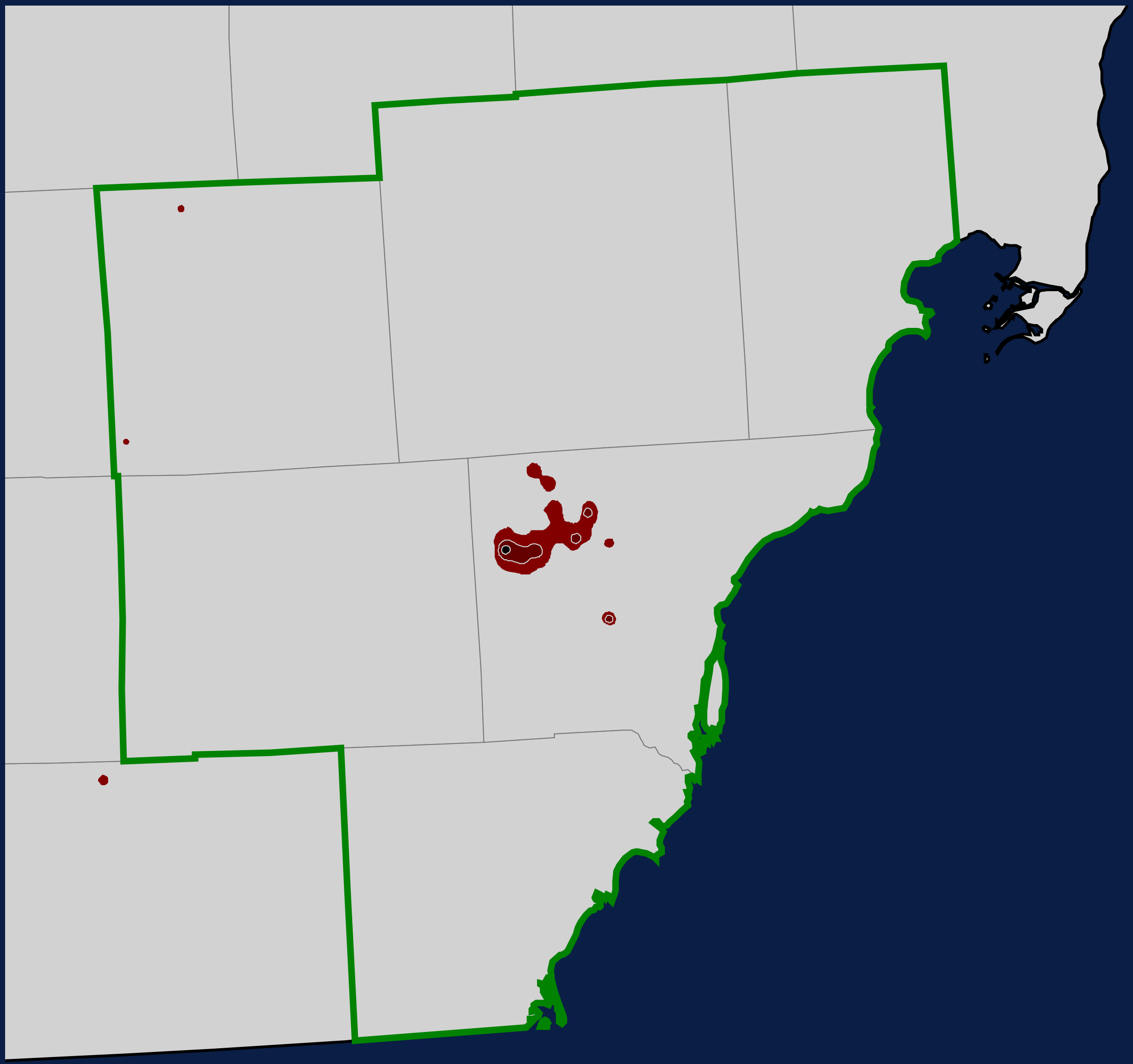
Preliminary Results

1997 ⟹ 1998



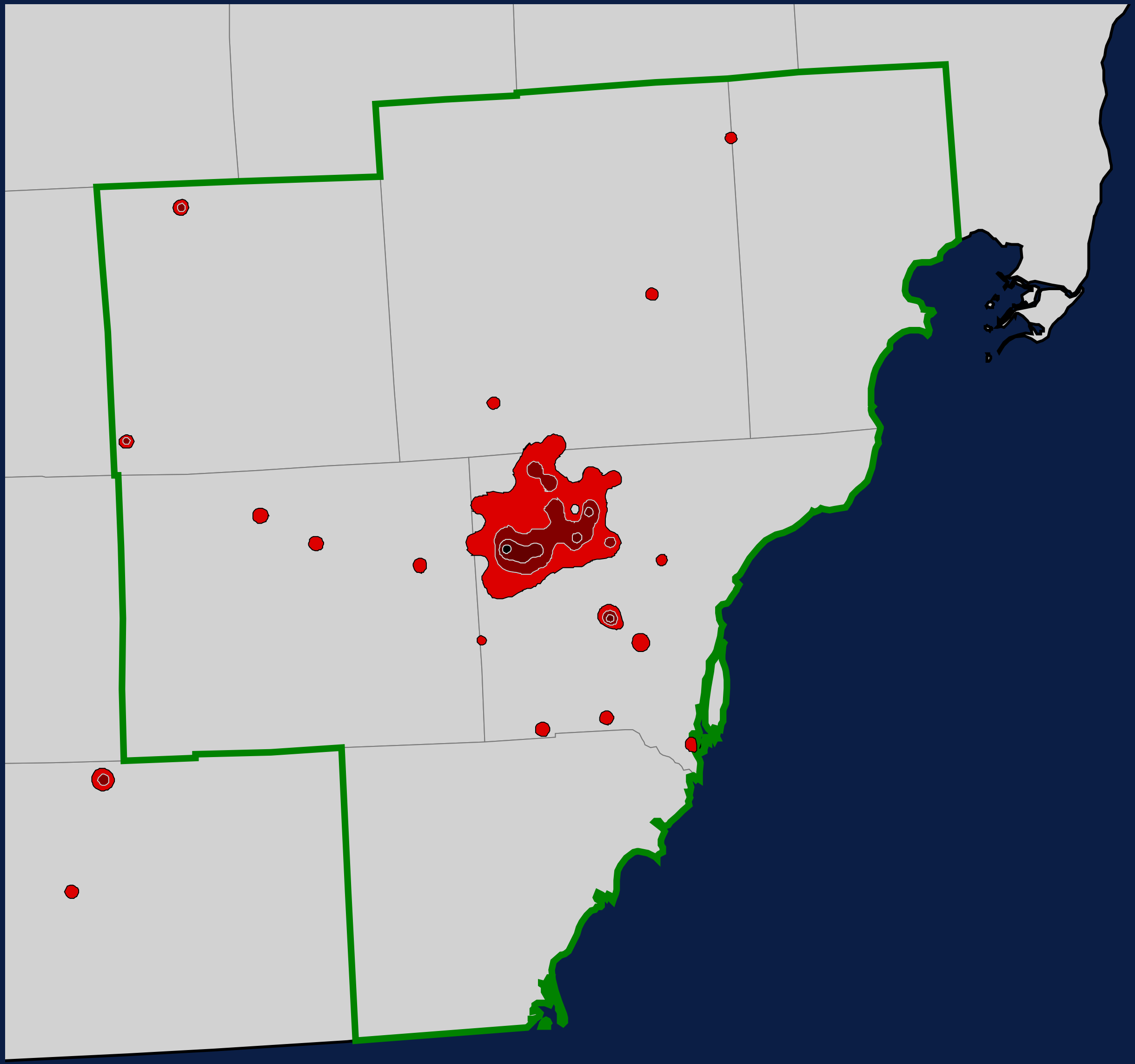
Preliminary Results

1997 → 1998 → 1999



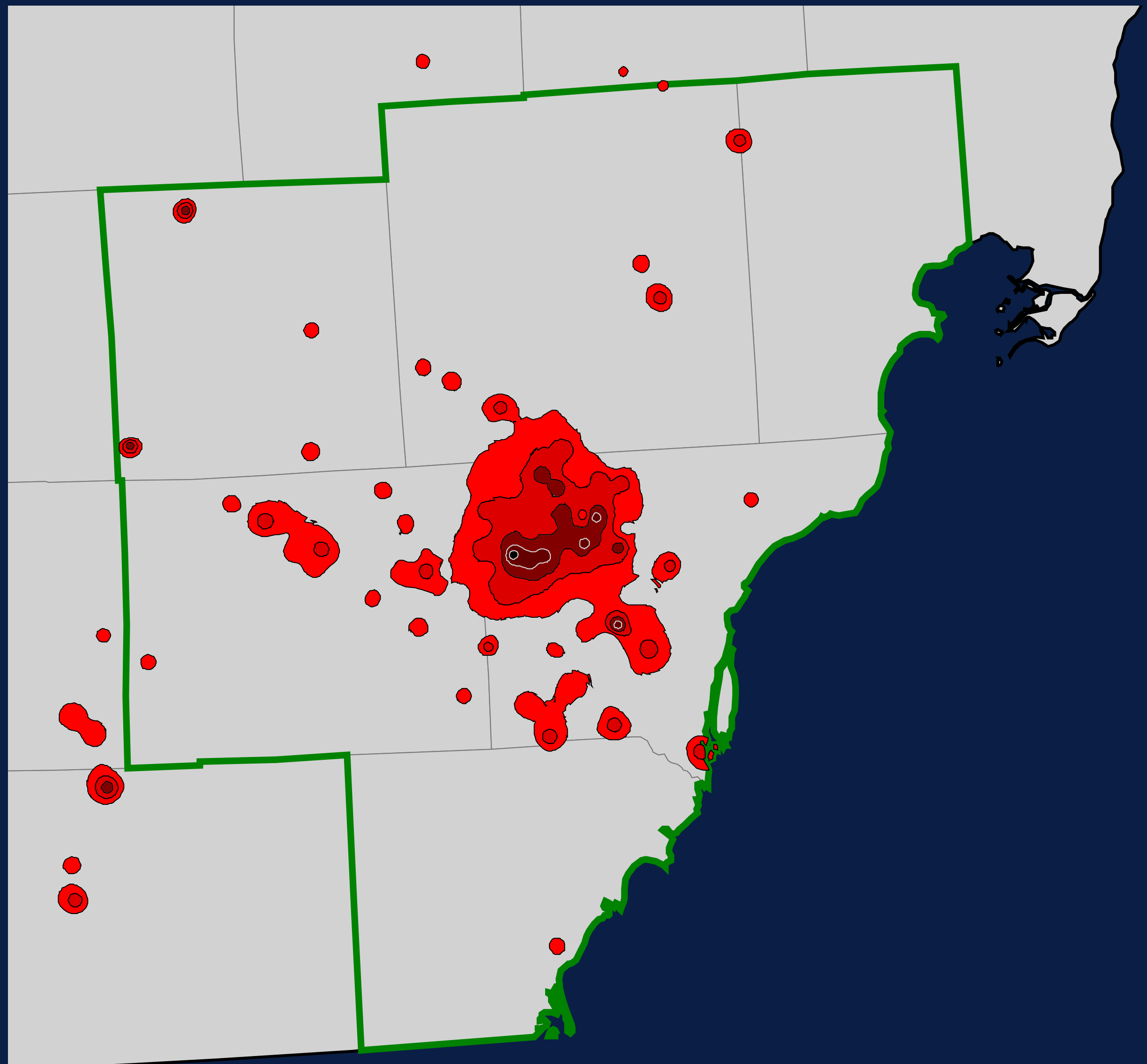
Preliminary Results

1997 → 1998 → 1999 → 2000



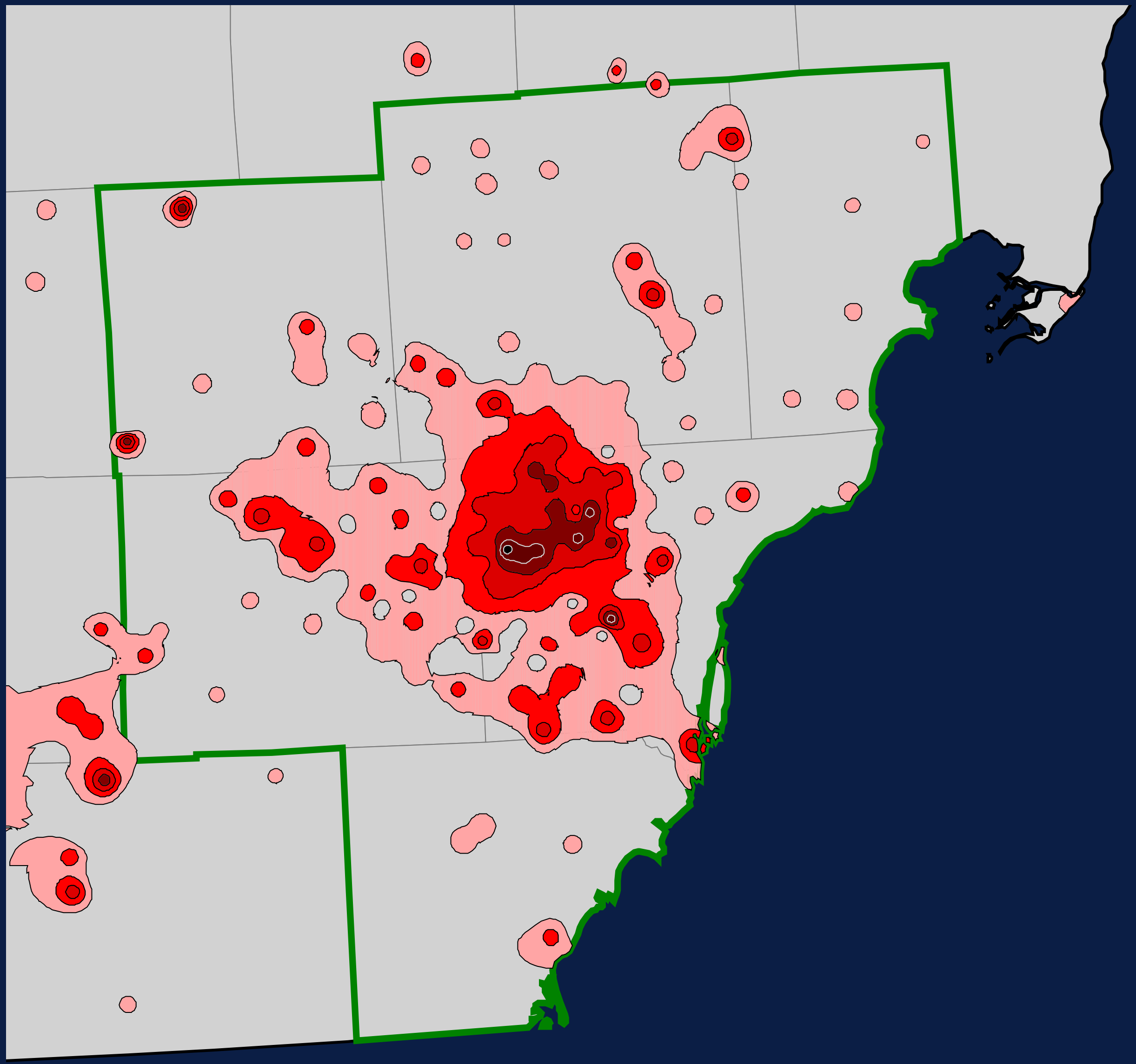
Preliminary Results

1997 → 1998 → 1999 → 2000 → 2001



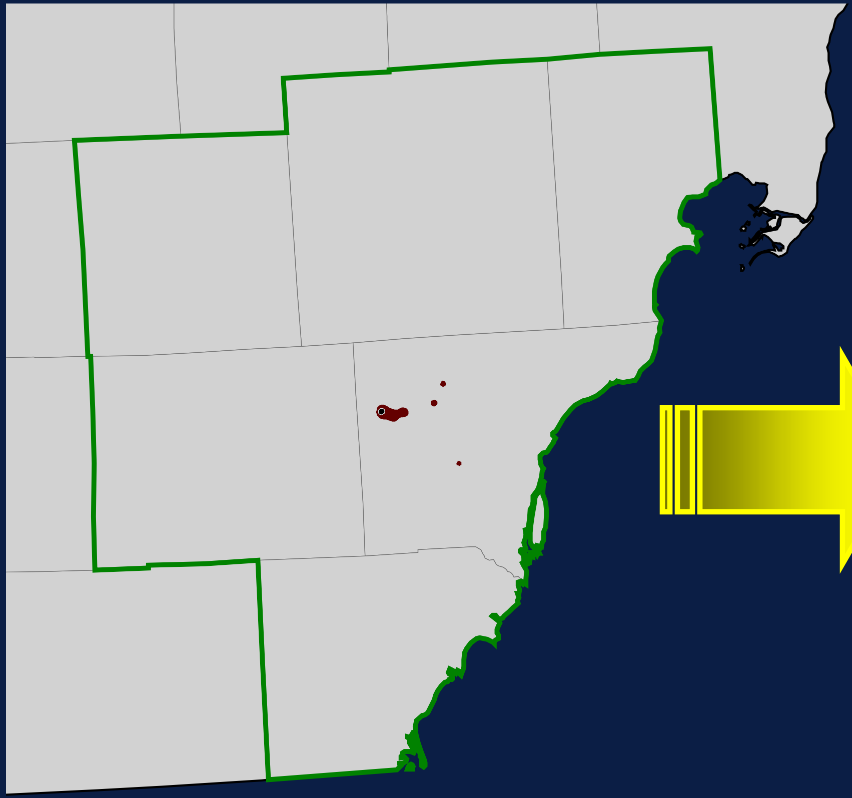
Preliminary Results

1997 → 1998 → 1999 → 2000 → 2001 → 2002

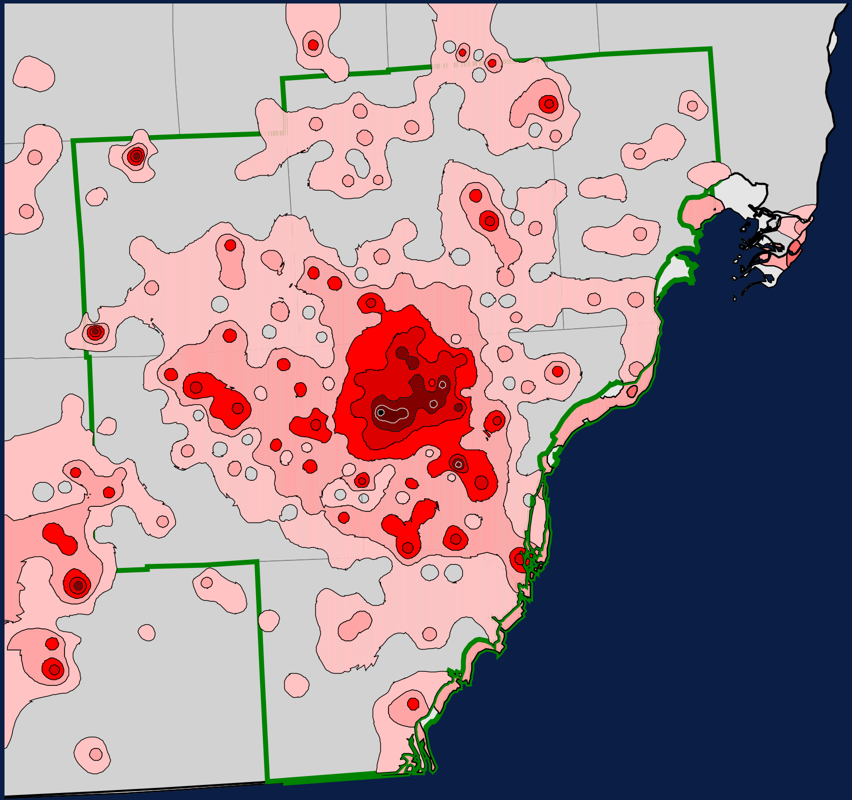


Initial Range Expansion

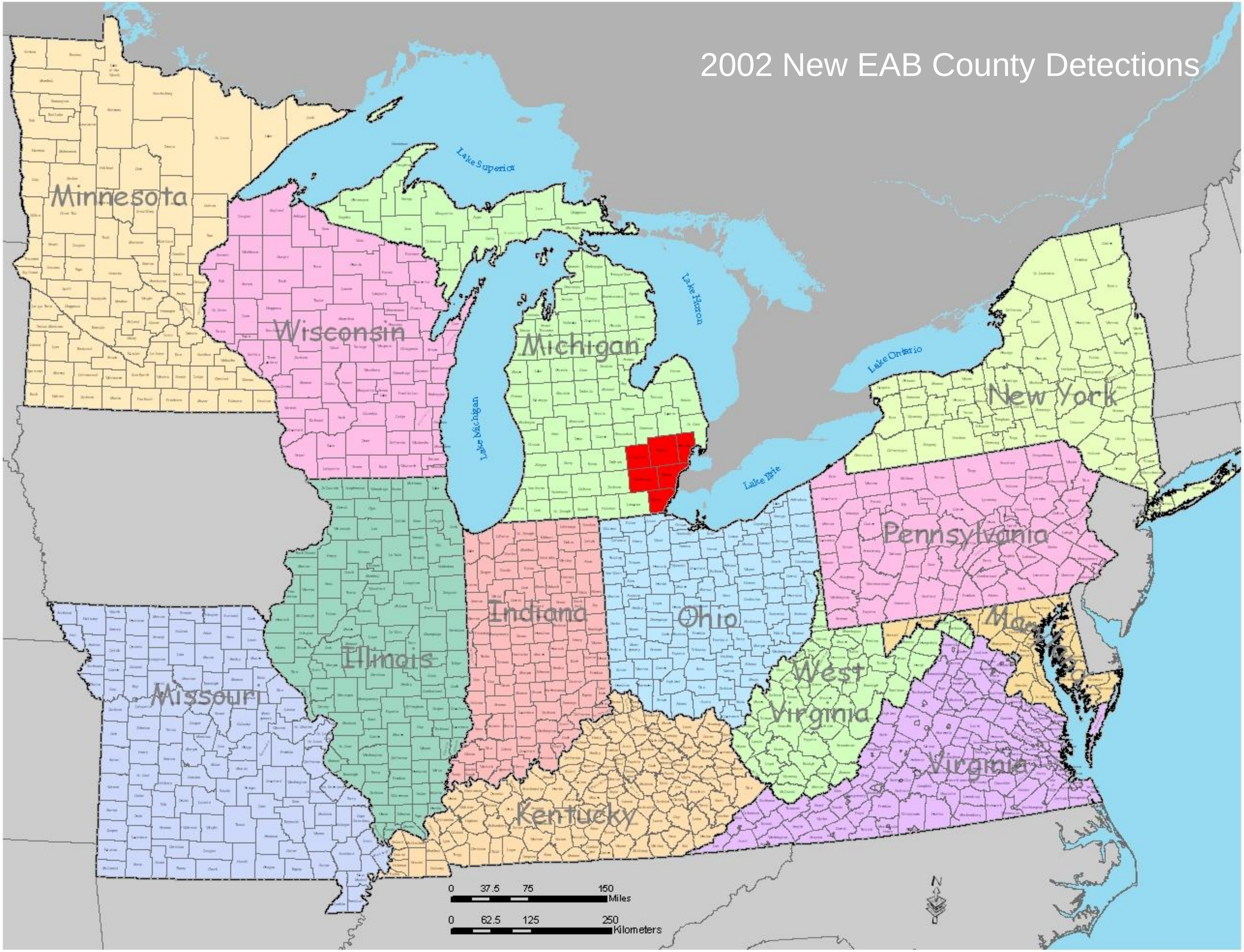
1998: ~10 km^2



2003: ~4800 km^2



In 5 years, area occupied by the core infestation increased 480-fold.


2002 New EAB County Detections
Minnesota
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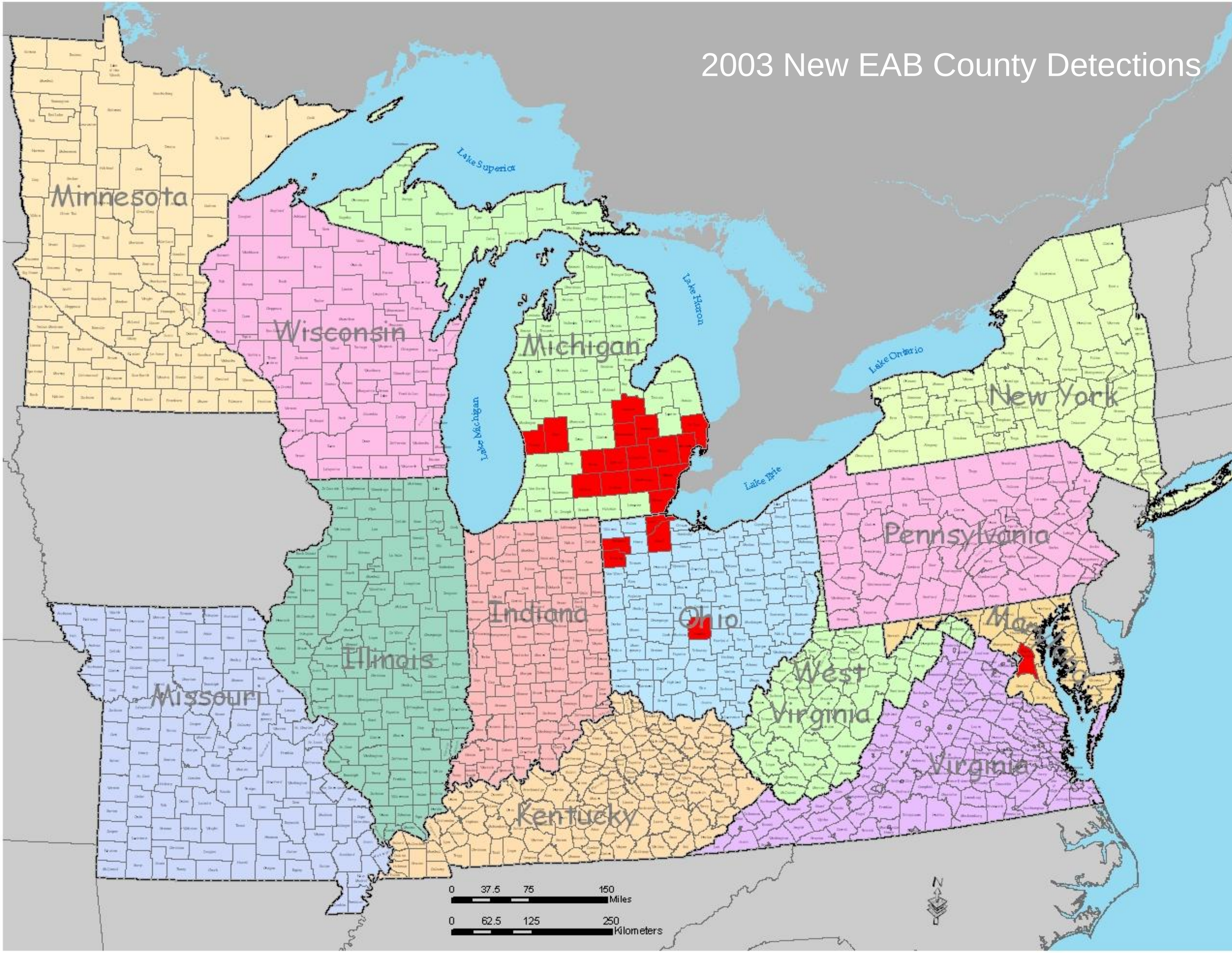
Pennsylvania
Ohio
Indiana
Illinois
Missouri
Kentucky
West Virginia
Virginia
Maryland
Lake Superior
Lake Michigan
Lake Huron
Lake Ontario
Lake Erie
0 37.5 75 150 Miles
0 62.5 125 250 Kilometers
N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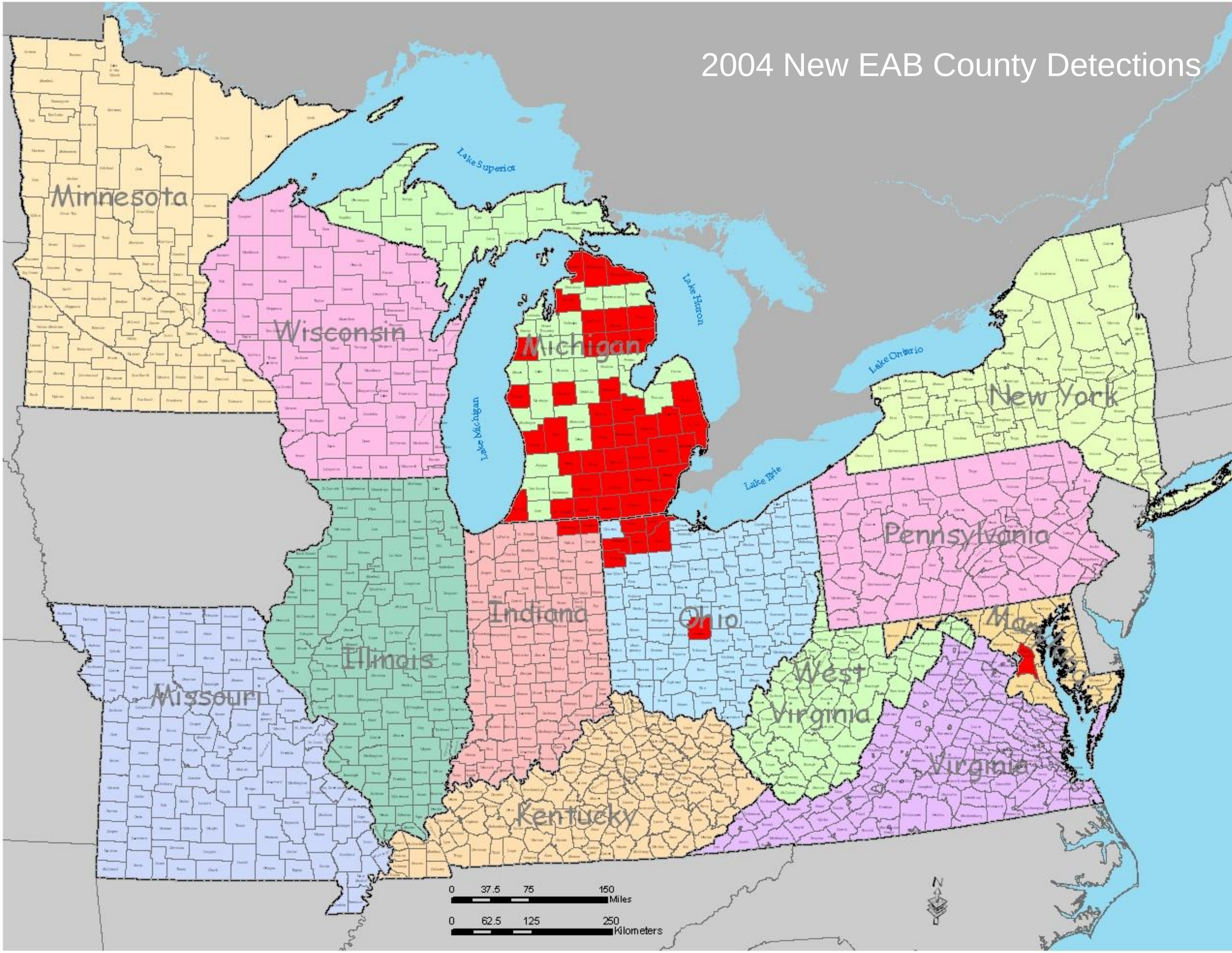

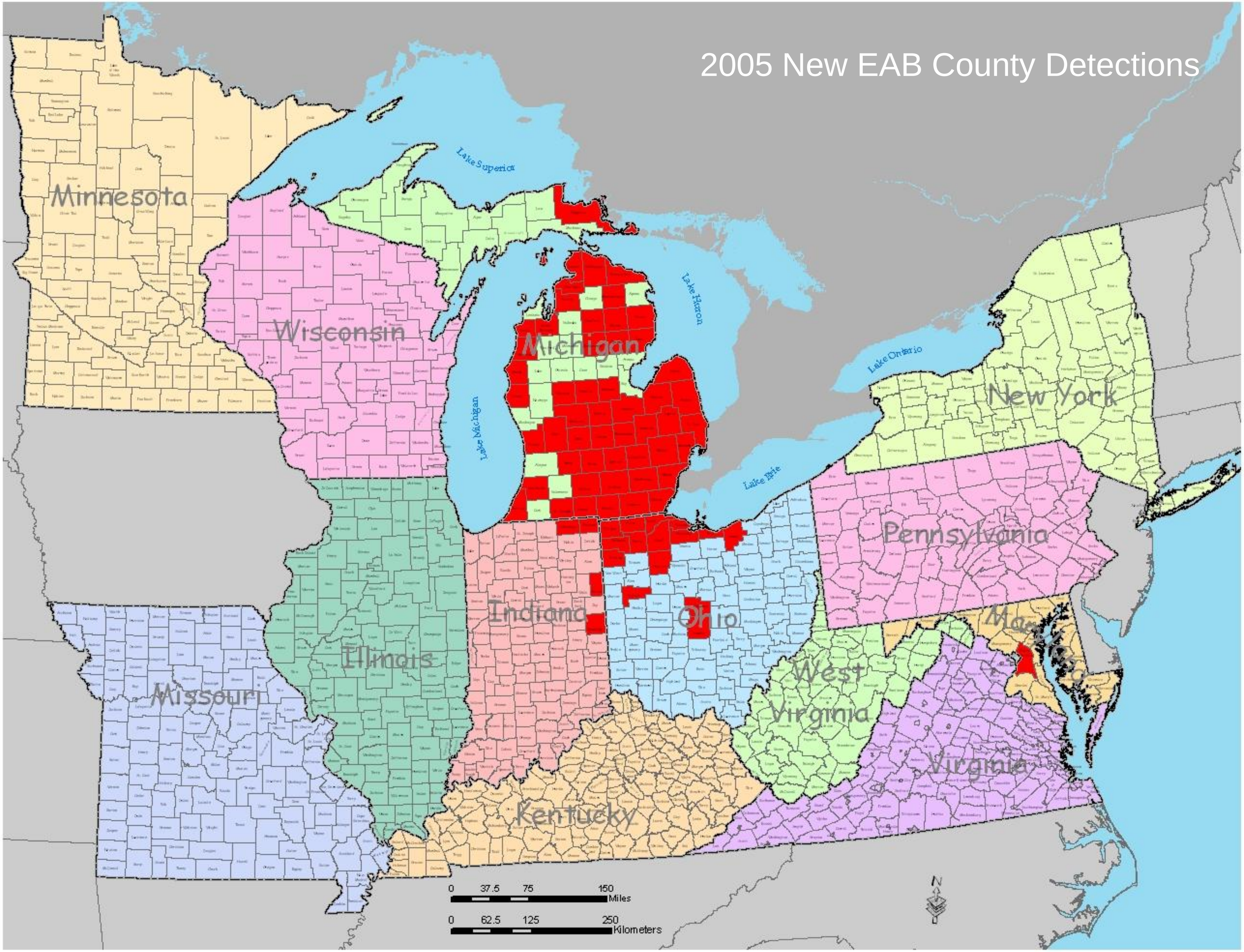

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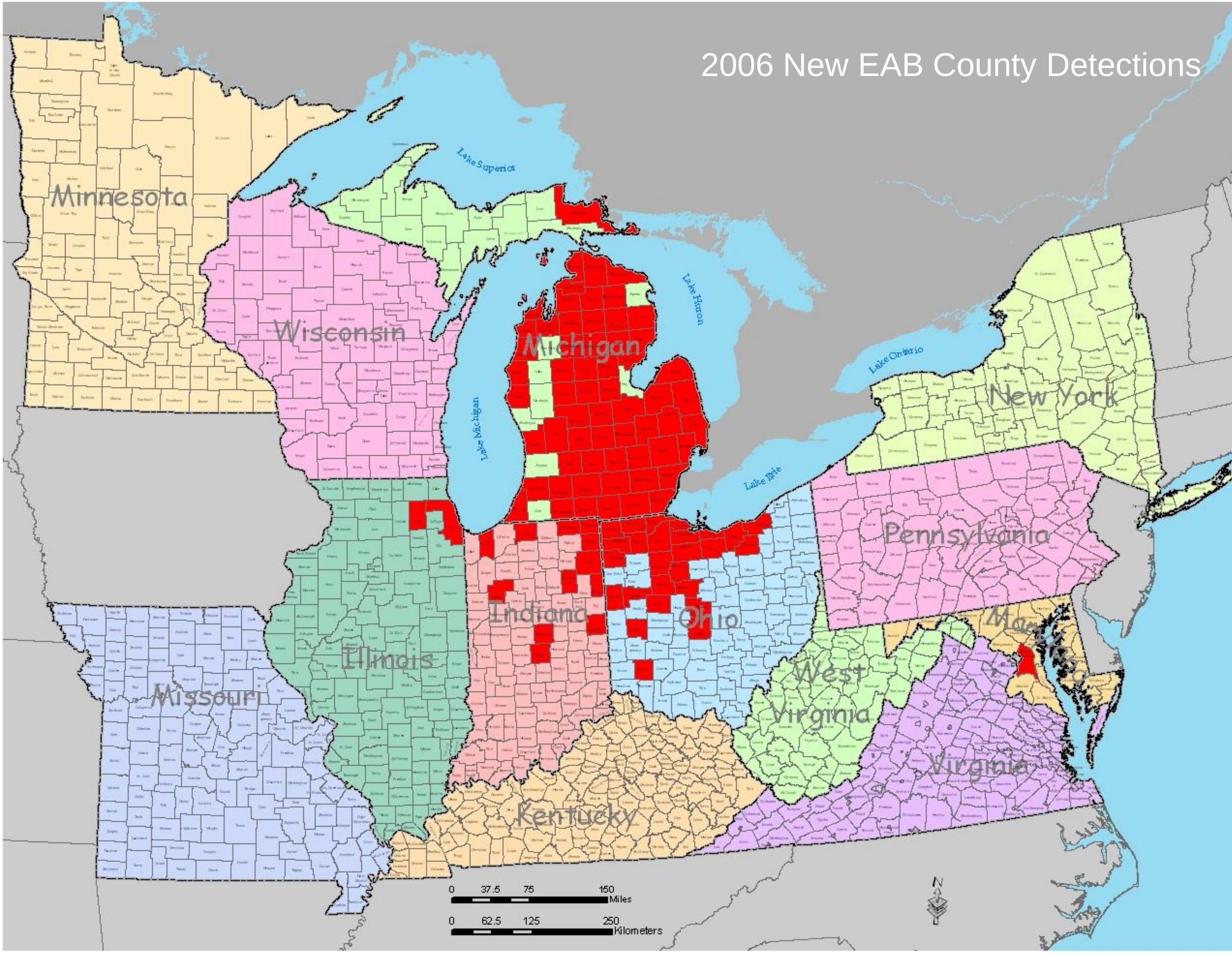
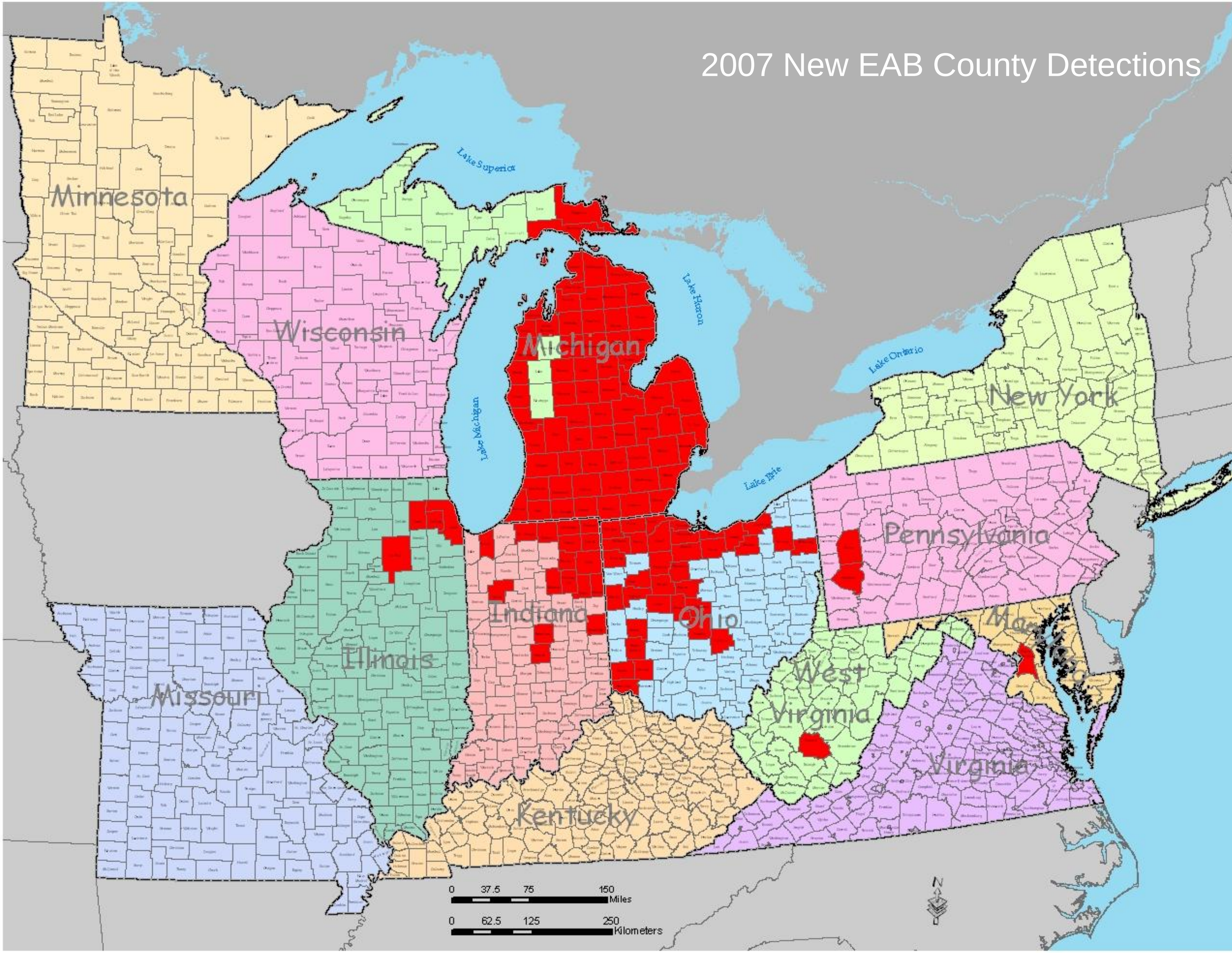
2006 New EAB County Detections

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Lake Erie
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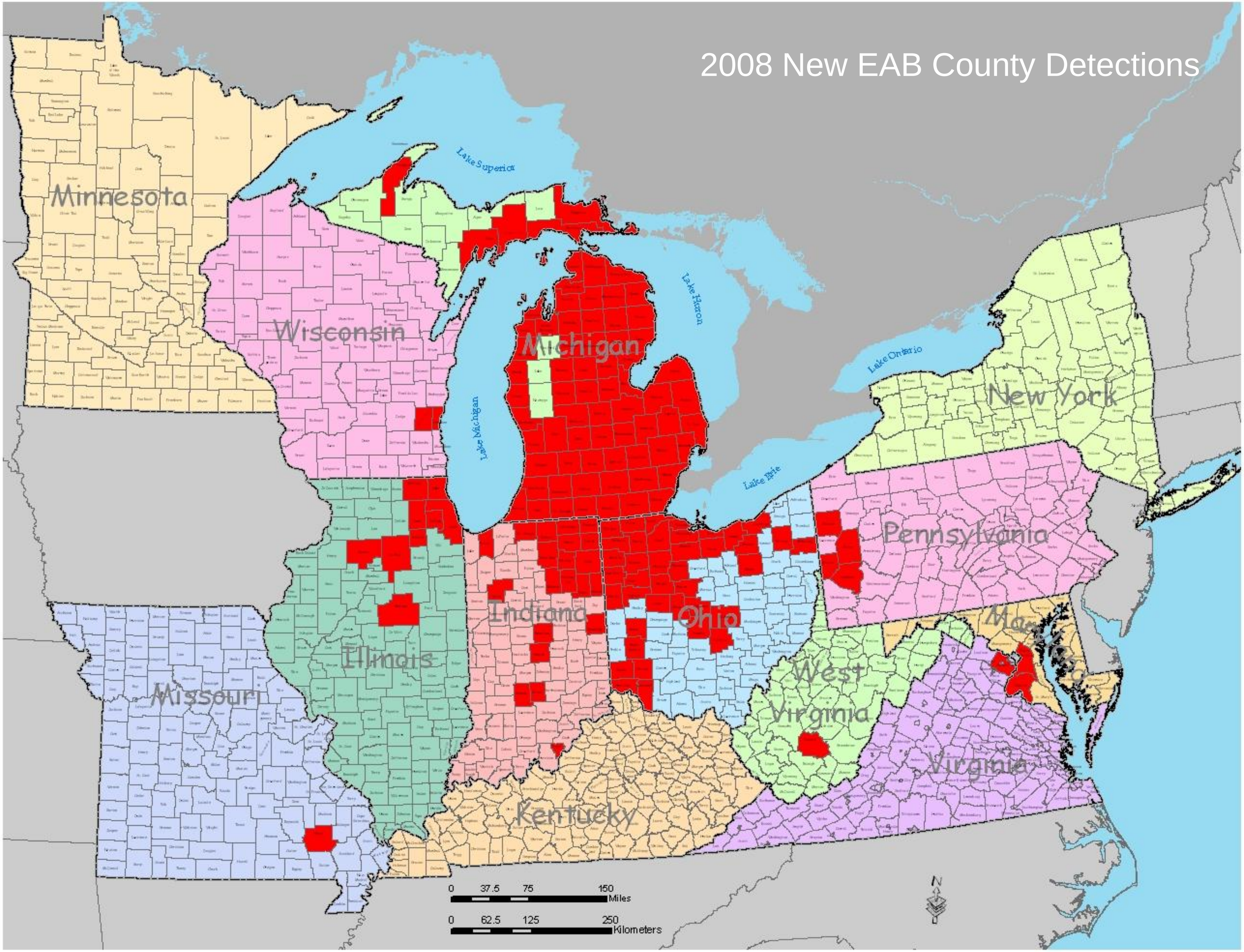
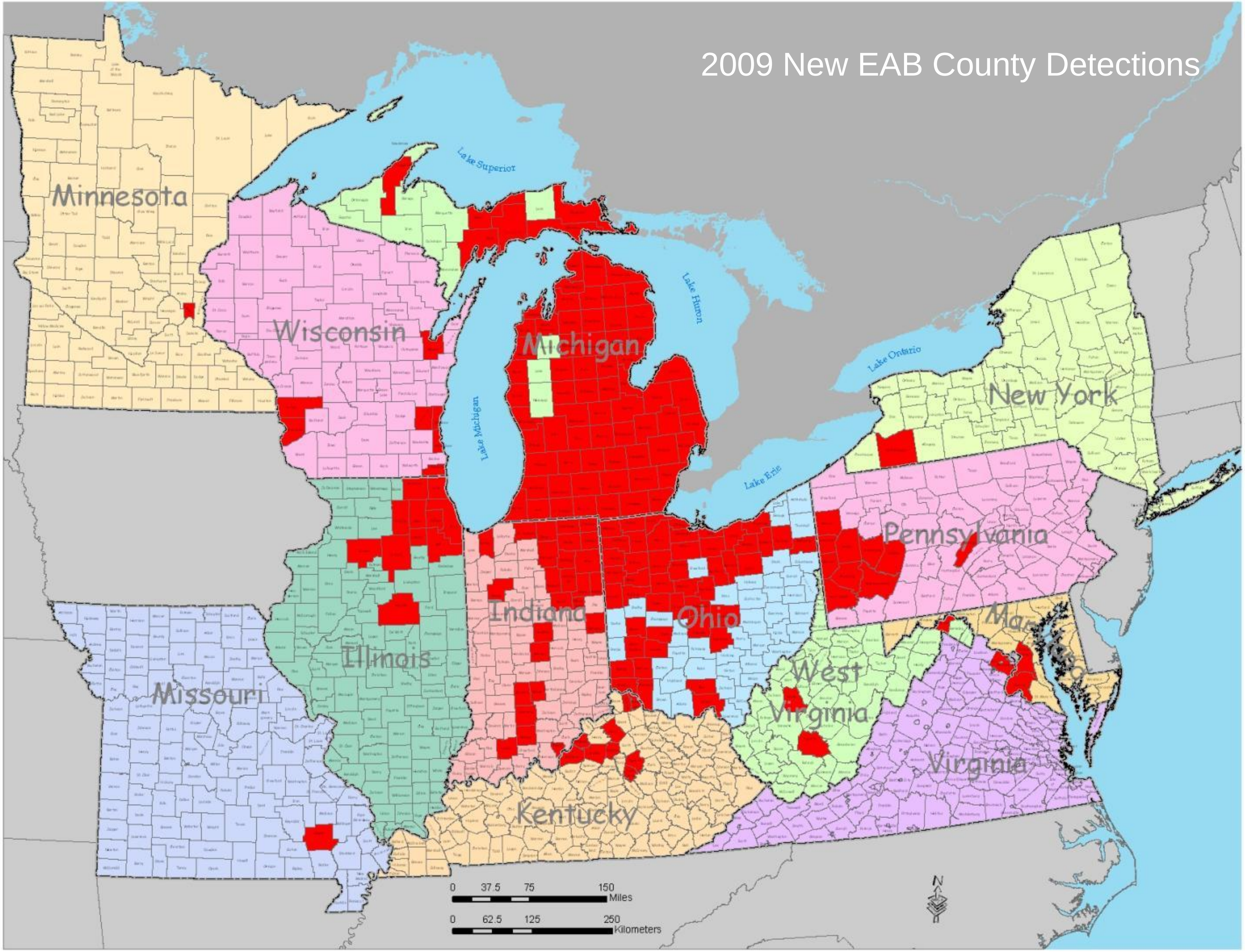
0 62.5 125 250 Kilometers
N

2008 New EAB County Detections




2009 New EAB County Detections
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Lake Ontario
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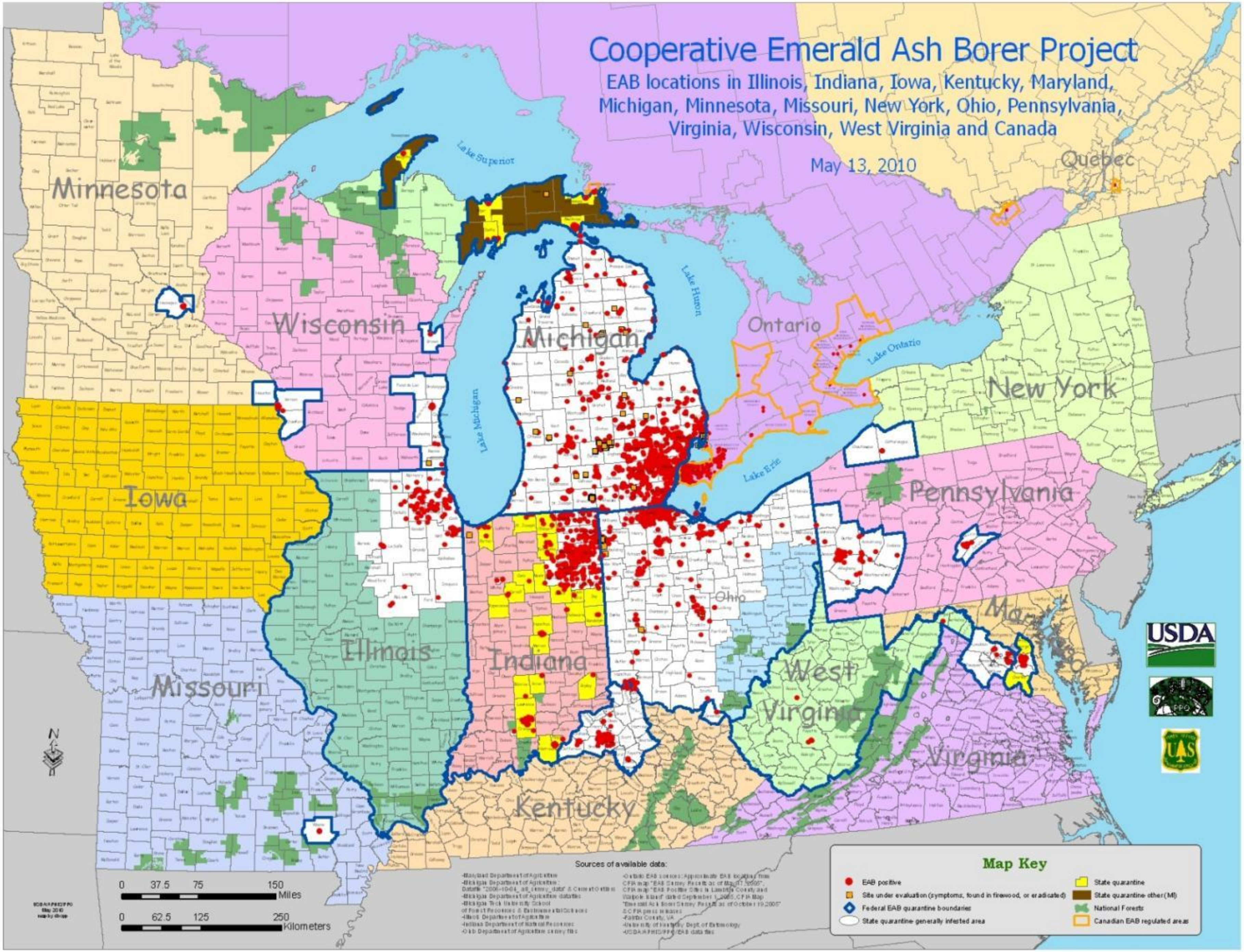
N


Cooperative Emerald Ash Borer Project
EAB locations in Illinois, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Missouri, New York, Ohio, Pennsylvania, Virginia, Wisconsin, West Virginia and Canada
May 13, 2010
Minnesota
Wisconsin
Michigan
Ontario
Quebec
New York
Pennsylvania
Iowa
Illinois
Indiana
Ohio
Missouri
Kentucky
West Virginia
Virginia
Lake Superior
Lake Michigan
Lake Huron
Lake Erie
Lake Ontario
USDA
Sources of available data:
-Fairfax County, VA
Map Key
EAB positive
Site under evaluation (symptoms, found in firewood, or eradicated)
Federal EAB quarantine boundaries
State quarantine generally infested area
State quarantine
State quarantine other (MI)
National Forests
Canadian EAB regulated areas
0 37.5 75 150 Miles
0 62.5 125 250 Kilometers

Where is EAB right now?

Remember that most new infestations are not found until dead trees appear, 3-4 years after an initial introduction

Acknowledgements

Michigan State University

Nate Siegert

Deborah McCullough

USDA – APHIS -PPQ

Phil Bell

Photo credits

Dave Cappeart

Debbie Miller